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Research Note

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EFFECT OF ROOTING MEDIUMS AND HORMONE APPLICATION ON ROOTING OF WESTERN WHITE PINE NEEDLE FASCICLES

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ABSTRACT

Two treatments, hormone application and a medium containing forest soil, produced equal but independent rooting responses in needle bundles obtained from 2-year-old western white pine (Pinus monticola Dougl.) seedlings. Apparent sources of variation in rooting response are discussed.

Personnel working in the western white pine blister rust resistance unit at this Station have initiated new investigations into the basic biology of blister rust resistance. These studies require application of genetic control on both the host and the pathogen. Studies concerning the rooting and vegetative propagation of western white pine (Pinus monticola Dougl.) seedling needle fascicles as a means of such host genetic control have been conducted by Hoff and McDonald (1968) and McDonald and Hoff.[2] These studies indicated that a culture medium of forest soil:sand:peat moss (1:1:1) might be of considerable value for stimulating the rooting of western white pine needle bundles. Further research on the rooting of these needle bundles is presented herein.

Doran (1940) rooted various species of hardwoods and conifers in both sand and a sandy loam with and without hormone (indolebutyric acid) treatment. The best rooting results were obtained with a sandy loam rooting medium plus hormone treatment applied to the needles. However, in most instances, the hormone treatment had no greater effect on rooting than did the sandy loam. Doran also found considerable variability in the response of different species to both rooting medium and hormone.

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[2] McDonald, G. I., and R. J. Hoff. Effects of Cronartium ribicola infection on rooting potential of detached Pinus monticola needle bundles. (In preparation)

Isikawa and Kusaka (1959) studied the rooting of needle bundles of Pinus thunbergii Parl. in two soil mediums with and without indolebutyric acid application to the bundles. One treatment, a "red soil" medium plus IBA application, gave 54 percent rooting compared to 0 and 8 percent for the remaining three treatments. According to Doran (1957) cuttings of Pinus strobus L. have generally rooted best in unused sand; but occasionally, used sand or sand:peat moss mixtures gave better results.

Deuber (1940) tested various types of sand and sand:peat mixtures and concluded that clean sand was the preferred medium because it caused a lower incidence of rot in the cuttings.

Delisle (1942) rooted cuttings and needle bundles of Pinus strobus L. in sand:peat moss mixture (2:1) with indoleacetic acid treatment. Thimann and Delisle (1942) reported the rooting of Pinus strobus L. needle bundles in a sand:peat moss mixture. Needle bundles taken from 3-year-old trees, and treated with auxin resulted in 74 percent rooting (71 out of 97) after 9 months. Jeckalejs (1956) rooted 17 out of 25 Pinus resinosa Ait. needle bundles by treatment with methoxane in a sand:peat moss mixture. Kummerow (1966) used clean sand to root Pinus radiata D. Don needle bundles, with his best results producing 61 rooted out of 100. Rudolph and Nienstaedt (1964) rooted Pinus banksiana Lamb. needle bundles in a sand medium. Their best treatment provided eight rooted bundles out of 10, after 8 months. Reines and Bamping (1964) reported 51 percent rooting from 30 needle bundles removed from 3-year-old Pinus elliottii Engelm., and 19 percent rooting from 30 needle bundles obtained from 3-year-old Pinus taeda L. when placed in a sand medium. Several different hormone treatments produced no significant effects.

MATERIALS AND METHODS

Needle bundles were removed from 2-year-old nursery grown Pinus monticola seedlings on March 5, 1968. They were removed by cutting through the short shoot. Some of the short shoots were dipped in Rootone[3] powder (Amchem Products, Inc., containing 0.067 percent naphthylacetamide, 0.033 percent 2-methyl-1-naphthylacetic acid, 0.013 percent 2-methyl-1-naphthylacetamide, and 0.057 percent indole-3-butyric acid). Both hormone-treated and untreated shoots were then placed in washed river sand or a mixture of this sand:peat moss:forest soil (1:1:1). The rooting mediums were contained in metal trays that were 14 inches wide by 20 inches long by 3.5 inches deep with drain holes in the bottom. Ten trays were prepared in the above manner according to the following treatment schedule: three received sand and untreated needle bundles; two received sand and Rootone-treated needle bundles; three received forest soil:sand:peat moss and untreated needle bundles; and two received forest soil:sand:peat moss and Rootone-treated needle bundles.

The completed trays were placed at random in a greenhouse under humidistat controlled mist nozzles with a relative humidity of approximately 50 percent, an air temperature of approximately 70°F., and a photoperiod of 16 hours. This system served to keep the trays moist but not waterlogged. Rooting was tallied on June 10, 1968. The needle bundles were taken from the blister rust test nursery and therefore were inoculated with Cronartium ribicola J.C. Fisch. ex Rabenh. The analysis of variance was carried out on percentages transformed by arc sin $\sqrt{\%}$ according to Snedecor (1956).

RESULTS AND CONCLUSIONS

The results of this study are presented in table 1. Data on C. ribicola needle lesions show that the level of such infection was nearly the same for all treatments. McDonald and Hoff[2] have discussed the relationships between this infection and the rooting of needle bundles.

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[3] The use of trade names herein is for identification only and does not necessarily imply endorsement by the USDA Forest Service.

Table 1.--Percentage of *C. ribicola* infection present and percentage of fascicle rooting under four different rooting medium-chemical treatment combinations

Medium	Number of fascicles treated	Rootone applied	*C. ribicola*[1] infection	Rooting
			- - - - Percent	- - - -
Sand	183	no	48	31
	212	no	40	23
	202	no	36	7
Sand	196	yes	47	50
	193	yes	44	45
Forest soil:sand: peat moss	188	no	47	45
	198	no	50	49
	187	no	38	55
Forest soil:sand: peat moss	202	yes	49	78
	203	yes	49	84

[1] *C. ribicola* infected needle bundles were included because infection could not be accurately assessed when the experiment was established.

Since most propagators use sand, this medium without chemical treatment was used as the base level. Either treatment of needle bundles with Rootone or addition of forest soil and peat moss to the sand produced a 30 percent increase in rooting (combined total: 60 percent); however, the significant result is that by adding both of these treatments an additional 30 percent (combined total: 90 percent) of rooting is obtained. This result indicates that the medium and the Rootone treatment have equal, additive, and independent effects on initiation of rooting in the species and under conditions of this experiment. This conclusion is statistically valid as shown by the analysis of variance in table 2.

Table 2.--Analysis of variance for the data of table 1

Source of variation	Degrees of freedom	Sum of squares	Mean square	*F*
Forest soil	1	888.87		[1]19.14
Rootone	1	769.18		[1]16.56
Soil X Rootone	1	6.23		.13
Residual	6	278.70	46.45	
Total	9	1,942.98		

[1] Treatment effect significant at 1-percent level.

DISCUSSION

Mergen and Simpson (1964) listed five main categories of factors which influence rooting of needle bundles in the pines. These categories were: (1) age of the ortet; (2) position of the fascicle on the ortet; (3) time of planting (basically physiological stage of development of the ortet); (4) chemical treatment; and (5) planting medium. Three additional categories are: (6) genetic background of the ortet which has often been observed in relation to rooting of cuttings (Kummerow, 1966) and was pointed out by Hoff and McDonald (1968) and McDonald and Hoff[2] in the case of P. monticola fascicles; (7) infection with an obligate parasite has an effect in special circumstances, reported by McDonald and Hoff[2] and (8) an eighth category which may be added for certain species (Ginzburg and Reinhold, 1967) is the presence of developed buds; however, this aspect needs further documentation.

The results thus far reported from this laboratory by Hoff and McDonald (1968) and McDonald and Hoff[2] have been based on 2-year-old ortets. A great majority of the needle bundles were removed from the apical leader. Consequently, variation of the factors described in categories 1 and 2 has been controlled. Variation of factors in categories 3 (physiological stage of development) or 8 (fascicular buds) may explain further observations. Categories 4 and 5 were examined in this study. The category 6 factor was controlled in this study by random selection of needle bundles from the nursery beds for all treatments. Although material from a different year's nursery test was used, approximately the same group of parents produced the progenies in all cases. The seventh category was controlled in the same manner. All needle bundles were infected to about the same frequency, as shown in table 1.

Hoff and McDonald (1968) reported 14 percent rooting of budded fascicles obtained from 2-year-old greenhouse seedlings, treated with Rootone and placed in a sand culture on February 4. This treatment and rooting success can be compared to the present treatment which also used sand and Rootone but gave 48 percent rooting. There were three differences between these two treatments: (1) the former was applied to greenhouse grown ortets and the latter to nursery grown ortets; (2) the former treatment contained only fascicles with developed buds and the latter contained no developed buds; and (3) the former contained only healthy fascicles and the latter contained 46 percent infected bundles. This third difference can be disregarded on the basis that infection lowers root initiation in the absence of Rootone (McDonald and Hoff[2]). This leaves the two differences of developed buds and greenhouse growth. The tendency is to attribute the difference in rooting to greenhouse conditions rather than to the presence of developed buds since Kummerow (1966), Isikawa and Kusaka (1959), and Rudolph and Nienstaedt (1964) have obtained relatively high rooting of budded needle fascicles obtained from other pine species. It is felt that greenhouse growing conditions may have shifted the physiologic growth cycle to a time of low rooting such as was observed for P. strobus cuttings by Deuber (1940). The essential fact is that growth of the greenhouse plants was about 2 months ahead of the nursery plants.

The reproducible nature of the rooting response is indicated by the close agreement between the present study and the rooting results obtained by Hoff and McDonald (1968) with a treatment of forest soil:sand:peat moss with no Rootone, and 50 percent infection. The two rooting values, 50 percent and 54 percent, were obtained in different years from different sets of progeny, although many parents were the same, and contained totals of 742 and 573 fascicles, respectively. The agreement between studies also shows that the method of watering does not have a great deal of influence, since in the earlier study the watering was intermittent (approximately every 2 days) and in the present study was more or less a continuous mist.

Each treatment produced striking results and contained sufficient numbers of needle bundles so as to leave little doubt about its effect on rooting. Unfortunately, there are two relationships that remain unknown. These are the interaction of infection and Rootone and the interaction of infection and medium. Information regarding these interactions was to have been obtained; however, by neglecting to class individual fascicles as either infected or healthy when the rooting was tallied, this opportunity was missed.

We have obtained rooting results nearly identical to those reported for *Cornus florida* L. by Doran (1940) where the effects of hormone application plus a medium containing soil were independent, equal, and additive. Doran speculates that auxin produced by soil bacteria and fungi could account for the soil effect. Other substances or actions produced by soil microflora could be important. More possibilities include substances exuded from living plants and materials derived from the decomposition of organic matter. One further observation is that since Doran's experiments did not include peat moss the implication is that the effects noted are due to the soil portion of the medium.

It is clear that both Rootone treatment of the needle bundles and the addition of forest soil and peat moss to the rooting medium have a large positive effect on rooting; consequently, it appears that a high percentage of needle bundles obtained from 2-year-old western white pine can be successfully rooted.

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